DEPARTMENT OF CLINICAL NEUROSCIENCE

K8F5522 Imaging in Neuroscience: with a Focus on Functional Magnetic Resonance Imaging Methods, 1.5 credits (hec)

Hjärnavbildning inom neurovetenskap: med fokus på funktionell magnetresonanstomografi metoderna, 1,5 högskolepoäng

Third-cycle level / Forskarnivå

Approval

This syllabus is approved by the The Committee for Doctoral Education on 2023-12-08, and is valid from Spring semester 2024.

Responsible department
Department of Clinical Neuroscience, Faculty of Medicine

Prerequisite courses, or equivalent

Background in cognitive sciences, psychology, medicine, biomedicine, biology, medical imaging, computational biology or any humanistic discipline where neuroimaging is used as an experimental tool.

Purpose & Intended learning outcomes

Purpose

The main purpose of the course is to enable the students to acquire solid understanding of the tools available to analyze brain activity data measured with functional magnetic resonance imaging (fMRI). The students will develop the ability to critically review results provided by different methods, to select the most adequate tools and experimental designs to answer different questions and to compare their relative advantages.

Intended learning outcomes

After attending the course the student should be able to: 1) describe the usual preprocessing steps of fMRI; 2) give a brief overview of different methods to analyze the data and explain when to use them; 3) conducte simple fMRI analysis using several methods; 4) be acquainted with experimental designs to answer different questions using fMRI; 5) give a brief overview of the usage of magnetic resonance imaging to study brain structure and function; 6) give a brief

overview of other techniques to study brain function non-invasively and describe their relative merits and challenges.

Course content

The course focuses on experimental design and analysis of fMRI data. We will briefly introduce the basis of the blood-oxygen-level dependent (BOLD) signal and how it is measured. The image processing steps, before statistical analysis, will be explained. The application of general linear model analysis to fMRI data will be explained, including random effects analysis and correction for multiple comparisons. We will discuss experimental designs for fMRI studies. The study of functional connectivity using fMRI data will be explained. We will also introduce machine learning techniques for analysis of fMRI data. Finally, structural measures of gray and white matter will be introduced as well as other techniques to measure functional and metabolic brain activity non-invasively.

Forms of teaching and learning

The course consists of lectures, hands-on sessions, group discussions and student presentations.

Language of instruction
The course is given in English.

Grading scale

Pass (G) /Fail (U)

Compulsory components & forms of assessment

Compulsory components

Attendance of at least 90 % on all parts of the course moments is compulsory.
In certain cases students can be exempted from participation in a moment of the course. In these cases the student can be asked to complete a compensatory assignment.

Forms of assessment

The learning outcomes will be assessed throughout the course during the hands-on sessions where the students have to perform data analyses. The students will also complete a more extensive assignment based on one of the hands-on sessions. In the final day of the course the students will present and discuss their assignments with the rest of the group.

Course literature

Recommended literature:

Poldrack, Mumford and Nichols, Handbook of Functional MRI Data Analysis, Cambridge University Press, New York, 2011.

Haynes, A primer on pattern-based approaches to fMRI: principles, pitfalls, and perspectives, Neuron 87: 257-270, 2015.
Lindquist and Wager, Principles of functional Magnetic Resonance Imaging, in Handbook of Neuroimaging Data Analysis. London: Chapman & Hall, CRC Press, 2014.
Jenkinson and Chappel, Introduction to neuroimaging analysis. Oxford University Press 2018.
Van Dijk et al. Intrinsic Functional Connectivity As a Tool For Human Connectomics: Theory, Properties, and Optimization, Journal of Neurophysiology 103: 297–321, 2010.